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BRIEF ARTICLE

Bypassing the gatekeeper: incidental negative cues stimulate choices with negative outcomes

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ABSTRACT
The Theory of Event Coding (TEC) predicts that exposure to affective cues can automatically trigger affectively congruent behaviour due to shared representational codes. An intriguing hypothesis from this theory is that exposure to aversive cues can automatically trigger actions that have previously been learned to result in aversive outcomes. Previous work has indeed found such a compatibility effect on reaction times in forced-choice tasks, but not for action selection in free-choice tasks. Failure to observe this compatibility effect for aversive cues in free choice tasks suggests that control processes aimed at directing behaviour toward positive outcomes may overrule the automatic activation of affectively congruent responses in case of aversive cues. The present study tested whether minimising such control could cause selection of actions that have been learned to result in aversive outcomes. Results showed incidental exposure to aversive cues biased selection of behaviours with learned aversive outcomes over behaviours with positive outcomes, despite a preference to execute the positive- over the negative-outcome actions evidenced by a separate behaviour measurement and self-reports. These results suggest motivational processes to select actions with positive consequences may sometimes be bypassed.
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Throughout our lives, we learn that actions have consequences. Once one has learned that certain actions generate positive or negative outcomes, selecting and executing actions with favourable outcomes and avoiding actions with aversive outcomes can be expected (Pavlov, 1927; Skinner, 1953). Recent research, however, suggests this need not always be the case. Building on ideomotor theory (for a comprehensive review of contemporary ideomotor theorising, see Shin, Proctor, & Capaldi, 2010), it has been demonstrated that after a certain behaviour has become associated with negative outcomes, being presented with a negative stimulus or anticipating negative action-effects can result in the activation and execution of the negative outcome producing behaviour (e.g. Beckers, De Houwer, & Eelen, 2002).

A theoretical framework that can account for this intriguing finding is the Theory of Event Coding (TEC; Hommel, Müsseler, Aschersleben, & Prinz, 2001). TEC integrates the common coding hypothesis of Prinz (1990) with the ideomotor principle developed by Lotze (1852) and James (1890). In short, ideomotor theorising suggests that actions are stored in memory by their sensory effects, and that action planning uses the anticipation of these effects to automatically retrieve the associated action. The common coding hypothesis suggests the cognitive representations of actions and their effects share a common representational domain (i.e. a common code). Hence, TEC assumes that due to the representational integration of actions and their effects, anticipating the outcome of a certain action, or being presented

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with a stimulus that shares features with learned action effects, will automatically activate the corresponding action due to the bidirectional nature of the action-effect associations.

How TEC can account for the processes fundamental to voluntary action has been demonstrated in an elegant study by Elsner and Hommel (2001), in which they put forward a two-stage model of action control. In their experiments, people first acquire associations between actions and effects through repeated co-occurrences. Next, in the second stage, people use these associations to guide goal-directed behaviour. Specifically, in an acquisition phase (stage 1), participants could freely choose between left and right key presses, which were followed by response-contingent tones of low or high pitch. In a subsequent test phase (stage 2), participants were presented with the same tones and were instructed to press the left or right key. Results showed that the keypresses of which the learned effects were congruent with the presented action-effects (i.e. tones of low or high pitch) were selected faster (in a forced-choice task) and more frequent (in a free-choice task) than incongruent keypresses. Hence, their study demonstrated how the integration of actions and effects into common representational codes allows for the automatic activation of actions by presenting learned action-effects.

Although initial studies provided evidence for TEC using non-affective action-effects (e.g. tones of high or low pitch), Eder, Rothermund, De Houwer, and Hommel (2015) conducted a series of experiments that provide evidence for the idea that the principles of TEC can be extended to affective events as well. Just like non-affective event features (e.g. colour, pitch, spatial orientation), affective event features are also integrated as part of the outcome of one's actions and can thus be used as retrieval cues. The authors showed that when actions and effects become associated through repeated co-occurrences in an acquisition-phase, presenting participants in a subsequent test-phase with response cues (i.e. cues to which participants needed to respond) of either positive or negative valence resulted in faster responses when the previously learned action effects matched the valence of the response cue (see also e.g. Eder, Dignath, Erle, & Wiemer, 2017; Hommel, Lippelt, Gurbuz, & Pfister, 2017). Negative cues prime affectively compatible behaviour even when the consequence is an aversive electric shock (Beckers et al., 2002).

However, almost all experiments to date used forced-choice tasks. Only one experiment of Eder et al. (2015) tested whether affective response cues elicit affectively congruent behaviour when people are free to decide which action to perform. Based on instrumental learning theory (Shanks, 1993), they expected that the motivational evaluation of action consequences should constrain ideomotor processes. Consistent with this theory, they found participants executed actions with positive outcomes more frequently in response to positive response cues, but they did not find such a compatibility effect for negative cues. Hence, it appears that motivational processes suppressed the initial activation of the action with negative consequences, preventing the selection and execution of harmful behaviour.

We do not challenge the existence of motivational processes operating in parallel with ideomotor processes. However, it could still be that there are circumstances in which such motivational control of behaviour might be less strong. Specifically, we suggest that previous work investigated the hypothesis while participants were put under conditions where some control can be expected (Eder et al., 2015), because the compatibility effects were studied in the context of a go/no-go- task. Inhibition of motor responses during a go/no-go task is known to instigate controlled processing that influences subsequent tasks such as gambling (proactive control; e.g. Verbruggen, Adams, & Chambers, 2012). Moreover, motor inhibition can suppress processing of simultaneously presented affective cues (so-called inhibitory spillover; Berkman, Burklund, & Lieberman, 2009). It is currently unclear how this go/no-go context exactly influenced these previous results, but it seems plausible that control processes were substantially engaged and may have interacted with the processing of the affective cues.

The present research aims to build upon the work by Eder et al. (2015) and investigate whether affective congruency effects following negative cues can be observed when controlled processing of the affective cues is minimised as much as possible. In our experiment the affective cues were presented incidentally during a simple task in which participants could freely decide to press either a left or right button. By presenting the cues during a basic binary button press task, and by making the affective cues completely task irrelevant, we aimed to minimise controlled processing of these cues. We adopted a similar two-stage experimental design as Eder et al. (2015) and Beckers et al. (2002), in which participants first learned affective consequences of their actions in an acquisition phase and were then presented with affective cues in the test phase. We expected that participants would be more likely to execute the response associated with positive outcomes when a positive stimulus was presented. More important, we also expected that when a negative stimulus was presented, more responses associated with negative outcomes would be executed, relative to responses associated with positive outcomes.

Method

Participants

55 students from Utrecht University (32 females) with a mean age of 21.4 ($SD = 2.5$) were recruited and received either course credit or a small monetary reward in exchange. At the time of conducting this study (late 2012), we based our sample size on previous research with similar experimental designs as ours (e.g. Eder et al., 2015; Lavender & Hommel, 2007) and aimed to include 50 participants in our study (we oversampled slightly in anticipation of having to exclude several participants from analysis). We acknowledge that this way of determining sample sizes may be suboptimal in light of recent discussions in the literature (e.g. Anderson, Kelly, & Maxwell, 2017). Post-hoc sensitivity analyses using G*Power 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009) indicated that we had a power of .80 to detect effect sizes of $d_z >= .34$ and a power of .95 to detect effect sizes of $d_z >= .45$ in one-sided dependent *t*-tests (i.e. for the simple effects).

Design

A mixed 2 (response outcome: positive vs. negative) × 2 (cue valence: positive vs. negative) × 2 (response window: short vs. long) × 2 (negative cue type: angry vs. sad emoticon) factorial design was used, with only negative cue type as between subjects factor. Response window and negative cue type were incorporated for exploratory purposes.

Apparatus, stimuli and procedure

All the stimuli were presented on a white background using 60 Hz monitors and QWERTY keyboards. Throughout the acquisition phase (but not in the test phase), participants wore (over-ear) headphones through which spoken words were presented, which served as the affective response outcomes.

Stage 1: acquisition phase

The acquisition phase consisted of three blocks. Both forced-choice and free-choice blocks were used in the acquisition phase for two reasons. First, the literature is unclear with regard to which method is most successful for acquiring action-effect associations (e.g. Herwig, Prinz, & Waszak, 2007; Pfister, Kiesel, & Hoffmann, 2011). Second, post-hoc we thought it may allow us to examine whether participants prefer actions with positive consequences over negative consequences, which should be expected when motivational processes play a role in these kinds of tasks.

In the first and the third block, (affectively neutral) cues were presented that indicated whether a left or right key-press was required (forced-choice blocks). In the second block participants could freely decide which key to press (left or right), and it was followed by the same action-effects as in the forced choice blocks. In the forced-choice blocks (block 1 and 3), each trial started with a message ("Attention") presented for 750 ms, after which a black fixation cross ("+") was presented for 750 ms. After the fixation cross, a triangle (equilateral with black sides of 300 pixels) and circle (black border and diameter of 300 pixels) would be presented in a quick, alternating fashion (for 1000 ms with each figure being shown five times for 100 ms at a time). Directly after the alternating figures, one of both figures would remain presented in the centre of the screen. This procedure was implemented to give the impression that the cues were presented randomly, and to ensure that participants closely attended to the screen. The figure would serve as the response cue and indicate which response was required. Participants were told to press the "z" key with their left index finger when the triangle remained on the screen or the "/" key with their right index finger when the circle remained on the screen (counterbalanced across participants). The response cue was presented for 750 ms or until the correct key was pressed.

Participants were instructed that in case of a response, an affectively laden word would be heard through the headphones while simultaneously the border of the response cue would thicken to signal the correct key was pressed. After 1350 ms, a blank screen was presented for 1000 ms after which the next trial would start. The spoken words were adopted from a list with affective ratings for Dutch words (Hermans & De Houwer, 1994) and consisted of 20 clearly positive (e.g. love, friend, sunshine) and 20 clearly negative (e.g. fear, heartless, murder) words (10 nouns and 10 adjectives each). In case of an incorrect response or response omission, an error message was shown repeating the required action for both cues. After 750 ms, respondents could press either key (i.e. "z" or "/") to continue to the next trial. Erroneous trials were not repeated.

In the free-choice block (block 2) each trial would again start with the "Attention" message and fixation cross, after which a green bar (width: 1000 pixels, height: 50 pixels) would progressively fill-up at the bottom of the screen in 400 ms. Participants were asked to use this time to decide which key they wanted to press, and to only press that key once a response cue was presented. The response cue was a rectangle (colour: cyan) of 256 pixels wide and 192 pixels high containing an exclamation mark with font Calibri (bold) and size 46 in the middle. Participants were asked to not respond according to a specific pattern but to instead respond as randomly as possible, as if each time they mentally flipped a coin to determine which key to press. After participants pressed either key ("z" or "/"), a blank screen was shown for 1350 ms while an affectively laden word was presented through the headphones. In case of an incorrect response (omission or key other than "z" or "/"), the instructions were repeated. For a visual presentation of the trial sequences in the acquisition phase, please see Figure 1. The forced-choice blocks consisted of 48 trials and the free-choice block of 32 trials with 10 practice trials, resulting in a total of 128 trials (excluding practice trials).

Self-reported measures of action valence. Before continuing to the test phase, participants were asked to indicate on a 7-point scale how pleasant they experienced it to be (1) to *choose* to press the "z" key with their left index finger, (2) to *choose* to press the "/" key with their right index finger, (3) to *press* the "z" key with their left index finger, and (4) to *press* the "/" key with their right index finger. These questions served as a subjective measure of response preference by checking whether keypresses conditioned to be positive were also rated as more positive, and, indirectly, to check whether the action-effect contingencies were successfully formed (see Section 1 of the Supplementary Materials for details).

Stage 2: test phase

Participants were informed there were going to be trials in which they had little time to decide which key to press and trials in which they had plenty of time to decide. Each trial would again start with the "Attention" message (1000 ms) followed by the fixation cross (750 ms). In the short trials, a positive or negative emoticon (i.e. the affective cue) was presented above a green bar that was progressively filling up in 400 ms. During this time, participants could not respond and were instead instructed to use this brief moment to decide which key they were going to press. Only after the 400 ms a grey border would surround the emoticon for 1000 ms (50 pixels around each side) indicating participants could press either the "z" or "/" key. Participants were again instructed to not respond according to a fixed pattern, but rather to respond as randomly as possible, as if each time they mentally flipped a coin to determine which key to press. The positive emoticon was a yellow smiling face and the negative emoticon was either a sad or an angry looking face (counterbalanced across participants). The emoticons were 250 pixels wide and 250 pixels high.

In the long trials, the fixation cross was followed by a positive or negative emoticon above an already filled up blue bar. The emoticon and bar had the same dimensions as in the short trial. The emoticon and blue bar were presented for 7000 ms, or until the "z" or "/" key was pressed. If no key was pressed after 7000 ms, a countdown would start, indicating participants had only 3 seconds left to press either key. Once either key was pressed, or if after 10.000 ms (initial 7000 ms plus the 3000 ms countdown) no response was given, the trial would proceed. No error message was shown in case of an incorrect response (omission or key press other than "z" or "/"), nor were there any response outcomes (i.e. affective spoken words) presented in either the short or long trials of the test phase.

A secondary task was given to check whether participants were attending to the screen during the task. At the end of each trial, an arrow of 200 pixels wide and 200 pixels high pointing either left or right was shown. Participants were asked to indicate the direction of the arrow (press the left key ("z") when the arrow pointed left or the right key ("/") when the arrow pointed right). The arrows were presented for 1500 ms or until the left or right key was pressed. In case of a correct response, a green border (50 pixels

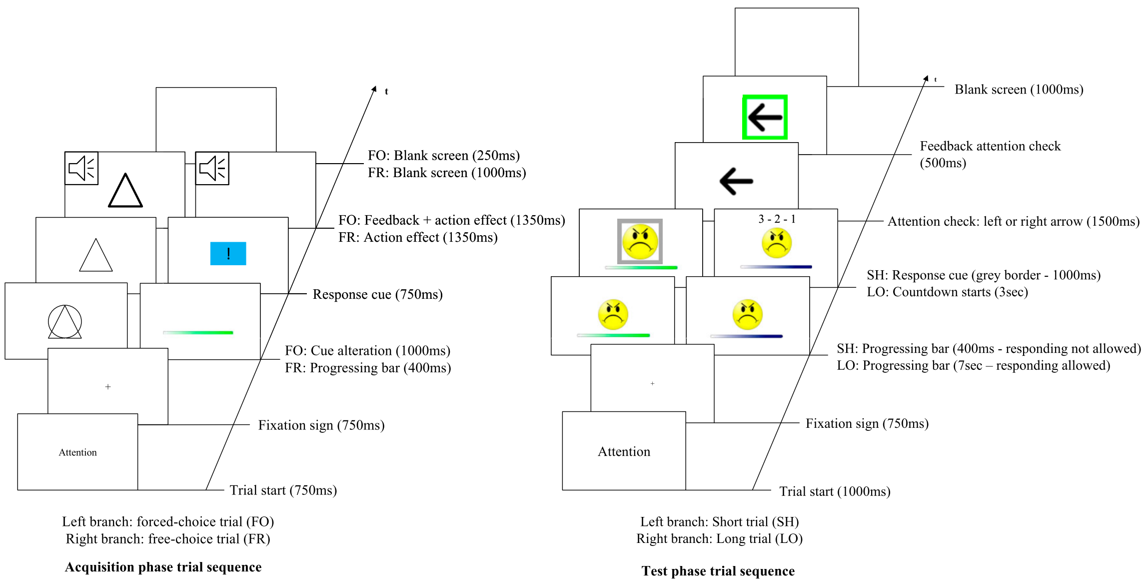

Figure 1. Acquisition and test phase trial sequence.

around each side) surrounded the arrow as a means of positive feedback. No feedback was given in case of an incorrect response. The next trial would start after a blank screen was presented for 1000 ms. For a visual presentation of the trial sequences in the test phase, please see Figure 1. Participants worked through 10 practice trials and 96 test trials.

Exit questions

At the end, participants were questioned on several aspects of the experiment. Most importantly, participants rated the emoticons that were used on several dimensions (i.e. positive, negative, angry, sad, happy) on a 7-point scale (the order was counterbalanced). Please see Section 2 of the Supplementary Materials for a complete overview of the post-test phase questions and the results.

Results

Exclusions

Inspection of individual performance data (see details in Section 3 of the Supplementary Materials) resulted in the exclusion of 11 participants. A final sample of 44 participants remained for analyses. Similar effects in terms of statistical significance and direction were found when the complete sample was analysed. Trials with response omissions were excluded from analyses (1.42% of all trials in the acquisition phase; 4.9% of all trials in the test phase).

Acquisition phase

A paired-samples t-test showed that in the free-choice block of the acquisition phase, keypresses with positive outcomes were performed more often (54.4%) than keypresses with negative outcomes, $t(43) = 2.23$, $p = .03$, $d = .67$, 95% CI [.07, 1.28], meaning that in the absence of affective cues, motivational processes directed action selection towards actions with positive outcomes. Analyses of the subjective measures of the action-effect contingencies (see Section 4 of the Supplementary Materials available online) indicated that participants preferred pressing the key that was conditioned to be positive. Hence, both behavioural and self-report data indicate that, in the absence of affective cues, participants preferred to perform the action associated with positive outcomes.

Test phase

Although the angry emoticon was rated as more negative ($M = 5.41$, $SD = 1.87$) than the sad emotion ($M = 4.41$, $SD = 1.62$), this effect was only marginally significant, $F(1,42) = 3.59$, $p = .07$, $\eta_p^2 = .08$, 90% CI [.00, 22], and this factor did not interact with the results reported below.[1] The data were therefore collapsed over this factor. A within-subjects ANOVA was conducted with response outcome, cue valence and response window as factors. The two-way interaction between response outcome and cue valence was significant, $F(1,43) = 21.24$, $p < .001$, $\eta_p^2 = .33$, 90% CI [.14, .48]. The three-way interaction did not reach significance, $F(1,43) = 3.55$, $p = .07$, $\eta_p^2 = .08$, 90% CI [.00, .22]. However, since the three-away interaction did approach significance and the effect size suggests this might be a meaningful effect, we conducted separate analyses for the interaction between response outcome and cue valence for both the short and long trials. Results indicated that the interaction was significant for both the short trails, $F(1,43) = 22.29$, $p < .001$, $\eta_p^2 = .34$, 90% CI [.15, .49], and the long trials, $F(1,43) = 16.68$, $p < .001$, $\eta_p^2 = .28$, 90% CI [.10, .43], only the effect size was slightly larger in the former. The simple main effects also demonstrated similar patterns for both trial types. Hence, the data were collapsed over this factor for subsequent analyses.

Simple effect analyses of the two-way interaction showed that in response to a positive cue, participants preferred to perform the action that was associated with positive outcomes (61.2%) relative to the action with negative outcomes, $F(1,43) = 10.37$, $p = .002$, $\eta^2 = .19$, 90% CI [.05, .35]. More importantly, when a negative cue was presented, more actions with a negative outcome were executed (59.9%) than actions with a positive outcome, $F(1,43) = 7.36$, $p = .010$, $\eta^2 = .15$, 90% CI [.02, .30]. No evidence for an incentive function was found in the test phase as there was no bias towards responses with a positive outcome ($F < 1$; see Figure 2). We conducted additional Bayesian analyses to supplement the frequentist statistics (see Section 5 of the Supplementary Materials), which led to the same conclusions.

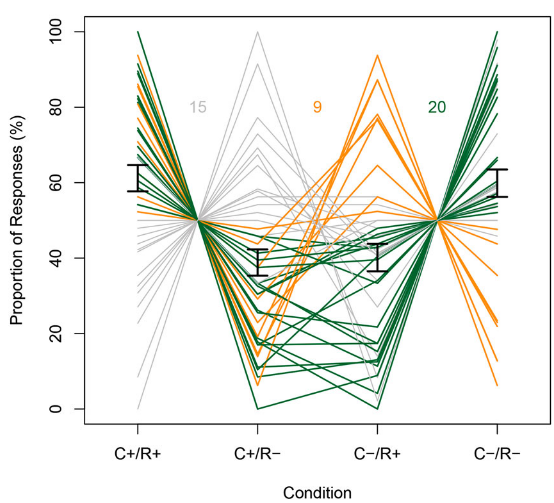

Figure 2. Probability of executing actions per condition. Thick black lines indicate the means and the standard errors per condition. Thin green lines show mean responses of participants ($N = 20$) who responded in line with the TEC hypothesis (C+R+ > C+R− and C−R+ < C−R−). Thin orange lines ($N = 9$) show mean responses of participants who preferred performing actions with positive outcomes (C+R+ > C+R− and C−R+ > C−R−). Thin grey lines show mean responses of the remaining participants ($N = 15$). See online version of this Figure for the colour version. C+ = positive cue. C− = negative cue. R+ = response with learned positive outcome. R− = response with learned negative outcome.

Discussion

The present study found that after the successful formation of action-effect associations, subsequent affective cues biased action-selection towards affectively compatible responses. Importantly, despite participants' preference for positive actions, incidentally presented negative cues still elicited a preference for actions with learned aversive consequences. Hence, it seems that motivational processes geared towards directing behaviour in the direction of functional outcomes were bypassed once incidental affective cues were presented. The present study is the first to demonstrate that aversive stimuli can bias action selection towards behaviour with aversive outcomes when people are free to decide which action to perform. We believe previous experiments (Eder et al., 2015) failed to demonstrate such a full affective compatibility effect in free-choice tasks because in these experiments participants were in a state of moderate cognitive control, as a Go-NoGo task was used to assess action selection.

Even though our study suggests that negative stimuli can trigger behaviours with previously learned negative effects when cognitive control is minimised, we cannot rule out that participants still executed some degree of control during the task. Therefore, we speculate whether we can also explain the current findings when we assume cognitive control was not lower compared to the Eder et al. (2015) study. The occurrence of affective compatibility effects depends on (1) the successful integration of actions and their effects into shared representational codes and (2) the successful retrieval of the action from memory when action effects are anticipated or primed. Hence, the fact that the present experiment did find a full affective compatibility effect can possibly be accounted for by (1) a stronger formation of the action-effect associations and/or (2) a more potent retrieval of the action from memory upon cue presentation. Arguments can be put forward for both.

Regarding the formation of action-effect associations, using salient auditory stimuli as action effects might have resulted in the formation of stronger response-outcome associations compared to less salient visual action effects as in Eder et al. (2015) study. Based on research that demonstrated that salient action-effects are more easily integrated with the action's representation and are therefore more resilient to extinction (e.g. Hommel, 1996), it could be that using auditory action effects results in stronger response-outcome associations. Second, the absence a full affective congruency effect in Eder et al.'s work (2015) can possibly be accounted for by less processing of the valence of response cues, because participants responded to non-affective dimension of the cues (e.g. they classified whether the cues represented animals or people), compared to when cues are incidentally presented as in our study (see also Lavender & Hommel, 2007).

A separate issue concerns the possibility that the results were influenced by demand characteristics, meaning participants were aware of both the action-effect contingencies and our hypothesis regarding affective compatibility, and because of this acted in line with our expectations. However, we do not consider this scenario to be very likely. Results showed incidental exposure to aversive cues biased selection of behaviours with learned aversive outcomes over behaviours with positive outcomes, despite a preference to execute the positive- over the negative-outcome actions evidenced by a separate behaviour measurement and self-reports. Nonetheless, future research would benefit from measuring awareness of both the action-effect contingencies and the study hypotheses. Eder et al. (2015) did measure contingency awareness and found their results were not dependent on awareness of the action-effect associations.

The most common pattern in the data was predicted by TEC. Nonetheless, more than half of the participants showed some other pattern. For instance, nine participants preferred executing actions with positive outcomes irrespective of the valence of the cues. Future work is needed to examine whether these individual differences are meaningful or are, for instance, the result of decision noise.

To summarise, the present study demonstrated that incidental perception of negative stimuli can bias response selection towards previously learned aversive behaviour in a free-choice setting. We hypothesise this finding is due to participants in our study not being in a state of heightened cognitive control, causing motivational processes aimed at directing behaviour towards more functional outcomes to be bypassed. However, before we can definitively attribute the findings to the level of cognitive control, additional research should investigate (1) the role of different types of action effects in the formation of response-outcome associations, and (2) the importance of directing one's attention to the affective content of a response cue for the successful retrieval of the associated action from memory.

Note

1. The four-way interaction nor the three-way interaction were significant when the full design was analysed (*Fs* < 1).

Disclosure statement

No potential conflict of interest was reported by the authors.

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References

Anderson, S. F., Kelley, K., & Maxwell, S. E. (2017). Sample-size planning for more accurate statistical power: A method adjusting sample effect sizes for publication bias and uncertainty. *Psychological Science*, *28*(11), 1547–1562.

Beckers, T., De Houwer, J., & Eelen, P. (2002). Automatic integration of non-perceptual action effect features: The case of the associative affective Simon effect. *Psychological Research*, *66*, 166–173.

Berkman, E. T., Burklund, L., & Lieberman, M. D. (2009). Inhibitory spillover: Intentional motor inhibition produces incidental limbic inhibition via right inferior frontal cortex. *Neuroimage*, *47*(2), 705–712.

Eder, A. B., Dignath, D., Erle, T. M., & Wiemer, J. (2017). Shocking action: Facilitative effects of punishing electric shocks on action control. *Journal of Experimental Psychology: General*, *146*, 1204–1215.

Eder, A. B., Rothermund, K., De Houwer, J., & Hommel, B. (2015). Directive and incentive functions of affective action consequences: An ideomotor approach. *Psychological Research*, *79*, 630–649.

Elsner, B., & Hommel, B. (2001). Effect anticipation and action control. *Journal of Experimental Psychology: Human Perception and Performance*, *27*, 229–240.

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G* power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*(4), 1149–1160.

Hermans, D., & De Houwer, J. (1994). Affective and subjective familiarity ratings of 740 Dutch words. *Psychologica Belgica*, *34*(2-3), 115–139.

Herwig, A., Prinz, W., & Waszak, F. (2007). Two modes of sensorimotor integration in intention-based and stimulus-based actions. *Quarterly Journal of Experimental Psychology*, *60*, 1540–1554.

Hommel, B. (1996). The cognitive representation of action: Automatic integration of perceived action effects. *Psychological Research*, *59*, 176–186.

Hommel, B., Lippelt, D. P., Gurbuz, E., & Pfister, R. (2017). Contributions of expected sensory and affective action effects to action selection and performance: Evidence from forced- and free-choice tasks. *Psychonomic Bulletin & Review*, *24*, 821–827.

Hommel, B., Müsseler, J., Aschersleben, G., & Prinz, W. (2001). The theory of event coding (TEC): A framework for perception and action planning. *Behavioural and Brain Sciences*, *24*, 849–878.

James, W. (1890). *The principles of psychology* (Vol. 2). New York: Dover Publications.

Lavender, T., & Hommel, B. (2007). Affect and action: Towards an event-coding account. *Cognition & Emotion*, *21*, 1270–1296.

Lotze, R. H. (1852). *Medicinische Psychologie oder die Physiologie der Seele*. Leipzig: Weidmann'sche Buchhandlung.

Pavlov, I. P. (1927). *Conditioned reflexes: An investigation of the physiological activity of the cerebral cortex (G. V. Anrep, Trans.)*. Oxford: Oxford University Press.

Pfister, R., Kiesel, A., & Hoffmann, J. (2011). Learning at any rate: Action–effect learning for stimulus-based actions. *Psychological Research*, *75*, 61–65.

Prinz, W. (1990). A common coding approach to perception and action. In O. Neumann & W. Prinz (Eds.), *Relationships between perception and action* (pp. 167–201). Berlin: Springer.

Shanks, D. R. (1993). Human instrumental learning: A critical review of data and theory. *British Journal of Psychology*, *84*, 3–19.

Shin, Y. K., Proctor, R. W., & Capaldi, E. J. (2010). A review of contemporary ideomotor theory. *Psychological Bulletin*, *136*(6), 943–974.

Skinner, B. F. (1953). *Science and human behaviour*. New York: Macmillan.

Verbruggen, F., Adams, R., & Chambers, C. D. (2012). Proactive motor control reduces monetary risk taking in gambling. *Psychological Science*, *23*(7), 805–815.